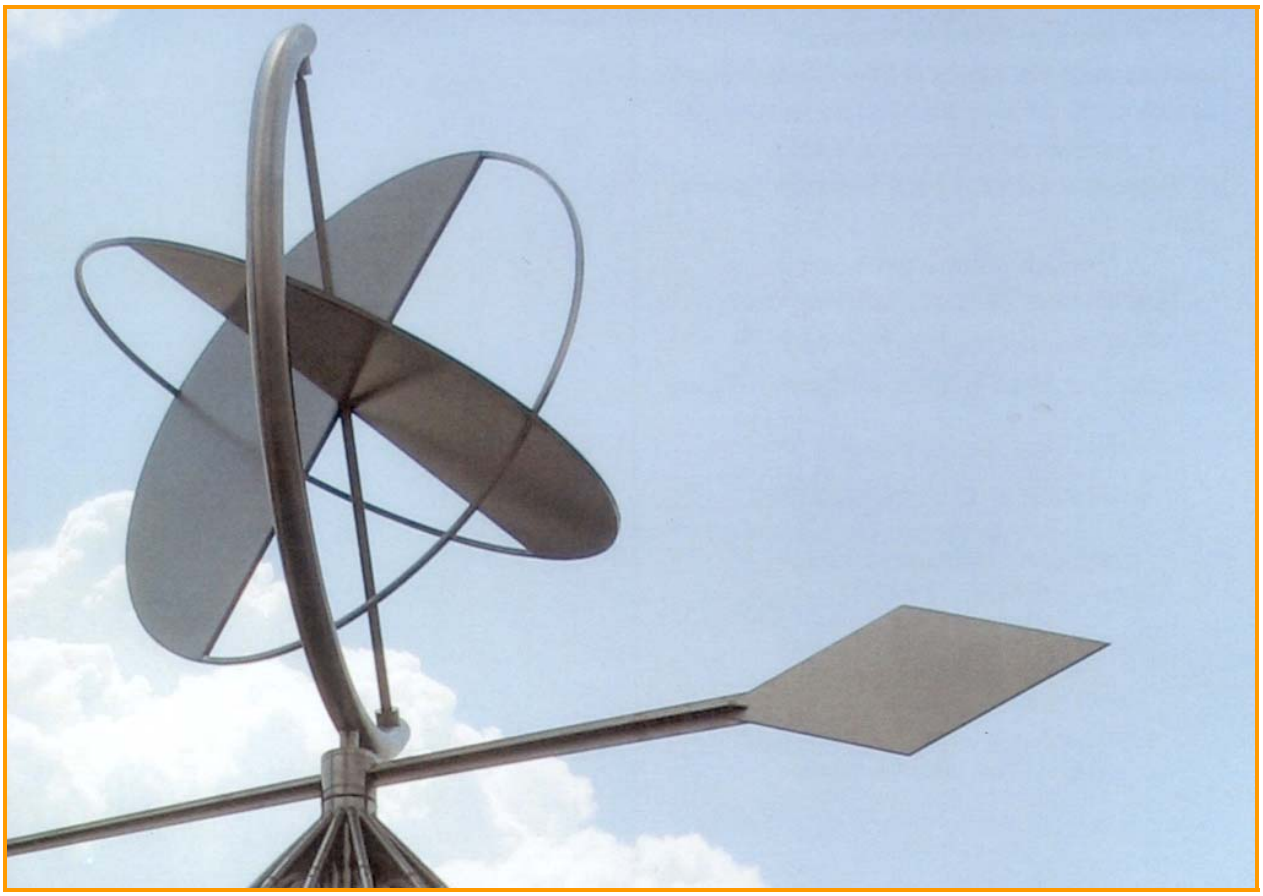
City of Richmond Heights



2008 Community-Wide & Local Government Operations Greenhouse Gas Emissions Inventory

Prepared by Teresa A. Robinson
FOCUS St. Louis Intern

1330 S. Big Bend Blvd.
Richmond Heights, MO 63117

Mime – *a public art piece created by artists Andrew Ginzel and Kristen Jones – is a 32-foot-tall stainless steel sculpture that celebrates the spirit and vitality of the Richmond Heights MetroLink station.* ***(Photo used with permission from Metro.)***

Credits and Acknowledgements

This has been a valuable learning experience and a chance to work with some really great people. Many people were needed to complete this project. I want to thank the City of Richmond Heights staff: Julie Echols (Human Resources Coordinator), Aviva Yael (Information Technology Coordinator), Irene Johnson (Public Relations Coordinator), Cindy Vilcek (Accounting Clerk), Kerry Hogan (Fire Chief), Joe Theirry (Facility Maintenance) plus many others, but especially Bola Akande (now City Administrator to the City of Brentwood), and Amy Hamilton, City Manager for Richmond Heights.

I also want to express gratitude to Brita Pagels, ICLEI Senior Regional Officer and John Wagner, Focus St. Louis, for providing guidance and support during this important project.

This inventory and report is the product of input from many sources. Allied Waste Services, Ameren Missouri, East-West Gateway Council of Governments, Laclede Natural Gas Company, Metropolitan St. Louis Sewer District, the City of Richmond Heights records, and many local businesses.

I also want to thank the Friends of the City of Richmond Heights for seeking positive changes to reduce greenhouse gas emissions in Richmond Heights.

Sincerely,

Teresa A Robinson
Washington University

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Version 1 of this document was found to have incomplete data after publication. This revised report has been updated to reflect the additional data.

Executive Summary

This report represents the completion of the Greenhouse Gas Emissions (GHG) Inventory for Richmond Heights. This GHG Emissions Inventory was performed with the assistance of consultation of ICLEI-Local Governments for Sustainability, using the process developed for their Cities for Climate Protection Campaign. The inventory utilized computer software developed specifically for this purpose: the Clean Air and Climate Protection software (CACP). This report represents the completion of the first step of five in a process intended to guide cities through the creation and execution of an action plan to reduce GHG emissions and energy use.

This Greenhouse Gas Emissions Inventory was conducted during the summer of 2011 and inventoried emissions released throughout 2008 for use as a baseline. The inventory was separated into two parts: municipal operations and the entire community within boundaries of Richmond Heights. The emissions from municipal operations are a subset of total community emissions and are included in the community emission data. They are reported separately in order to provide information that can be used to develop appropriate policy for both municipal operations and for the community as a whole.

This report provides data to guide the design of a local action plan but does not include that plan. For major reductions in GHG emissions to occur, the sectors of the community which consume mass quantities of carbon-intensive fuels must find alternatives. This report identifies those sectors. This report also identifies costly fuel sources. It is important to note that programs that realize costs savings require analysis that is outside the limit of this report, especially analysis of implementation costs.

Major Findings

Community Emissions and Energy Use

- In 2008, the City of Richmond Heights emitted approximately 243,621 metric tons of CO_2e.
- Government operations in Richmond Heights contributed 3,229 metric tons CO_2e which is 1.33% of total community emissions.
- Transportation contributed the majority of community emissions at 50.5 percent.
    - Transportation emitted 123,150 metric tons of CO_2e.
- The Commercial sector emitted 74,688 metric tons CO_2e.
- Per capita residential electricity use was 19,228 kWh in 2008.
- GHG emissions are forecasted to increase 3.8% to 252,822 despite population loss.
- Buildings emitted the largest percentage of government emissions at 87%.
- The City of Richmond Heights spends a significant portion of the budget on exterior lighting but currently has no input into the type of lighting used.

Introduction

On February 8, 2011, the City of Richmond Heights signed onto the U.S. Mayor's Climate Protection Agreement, committing to reduce GHG emissions of the community at large to 7 percent reduction below 1990 emission levels by 2012. Additionally, after Mayor James J. Beck signed Resolution No. 11-02, Richmond Heights's City Council directed staff to develop a comprehensive policy for the local government itself to lead by example. Emissions attributable to government operations will be reduced to 15 percent below 2008 emission levels by 2013. Through the Department of Energy's Efficiency and Conservation Block Grant program, the City of Richmond Heights received funding to carry out an Energy Efficiency and Conservation Strategy (EECS) which will reduce energy spending, spur local jobs, and mitigate GHG emissions simultaneously. This inventory supports the long-term efforts of Richmond Heights to reduce emissions and is critical to clearly understanding our contribution and path toward fighting the problem of climate change, here, at home.

A greenhouse gas inventory is an estimation of the amount of greenhouse gases emitted into the atmosphere over a specific period of time, usually one year. A greenhouse gas inventory gives information on the activities that cause emissions, as well as the assumptions and background on the methods used to make the calculations. Policy makers use greenhouse gas inventories to track emission trends, develop strategies and policies and determine progress. Scientists use greenhouse gas inventories for atmospheric and economic models. [1]

Richmond Heights, with an area of 2.3 square miles, is a traditional community located in the heart of the St. Louis metro area. Richmond Heights has a diverse population of about 8,600 people residing in 4,244 households.[2] Richmond Heights contains established, desirable neighborhoods, with quality public and private schools, and provides high-quality city services. Richmond Heights is minutes away from many regional attractions and features, such as Lambert International Airport, public and private colleges, sports venues, cultural attractions, the best of medical services, and the landmark Forest Park. The MetroLink light rail line network provides residents, shoppers, commuters and other visitors with increased transportation options to and

from our city via the station located on Galleria Parkway just east of Saint Louis Galleria and The Boulevard-Saint Louis.

The City of Richmond Heights recognizes that greenhouse gas emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community. In response, the City of Richmond Heights has taken action to understand the sources of these emissions within our community through the completion of a greenhouse gas emissions inventory. The results of that study are included in this report. The City of Richmond Heights has multiple opportunities to benefit by acting quickly to reduce GHG emissions, both through local government operations and by inspiring action throughout the community. The detailed findings of this report provide a profile of emissions sources within the City of Richmond Heights, information that is key to guiding local reduction efforts. This inventory is also useful in that it establishes a benchmark or emissions baseline that the City can later use to evaluate the success of our efforts and compare GHG emission levels over time.

Presented here are estimates of greenhouse gas emissions resulting from activities in Richmond Heights as a whole and from the City's government operations in 2008. The data will provide a baseline against which the City of Richmond Heights will be able to compare future performance and demonstrate progress in reducing emissions. The Cities for Climate Protection Campaign has outlined a five step process for reducing GHG emissions. The steps are:

1. Conduct a baseline emissions inventory and forecast.
2. Adopt a target quantity for emission reduction by the forecast year.
3. Develop an action plan to achieve the targeted reduction quantity.
4. Implement policies and take actions to meet goals.
5. Monitor and verify results.

Because the City of Richmond Heights intends to sell off a significant number of real estate holdings in the near future, data was gathered at the facility level (where possible) to create a baseline emission inventory number for existing assets separating the properties in question. This was done to ensure as much accuracy as possible for the inventory process both for the present and future.

While detailed and exact data was the highest priority during the inventory, some data limitations are to be expected. In these cases, assumptions were required to complete small parts of the inventory. Assumptions are noted in the inventory and more information is included in the appendices. Totals may not add up to exact numbers due to CACP software rounding. The totals are off by a very small amount, which is within the expected rounding limits.

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ICLEI Climate Mitigation Program

Richmond Height has joined ICLEI – Local Governments for Sustainability, an association for local governments to share knowledge and successful strategies toward increasing local sustainability.[1] ICLEI members represent the most forward-thinking and adept local governments who are working to make their communities more livable, prosperous, equitable, and environmentally sound. The network is a source of continual technical and local innovative thinking designed to help local governments achieve the vision of a truly sustainable community.

Benefits of Performing a Greenhouse Gas Inventory

Climate experts predict that GHG emissions will require substantial reduction to mitigate extreme climate change. The City of Richmond Heights chose an initial target reduction of 15

[1] ICLEI was formerly known as the International Council for Local Environmental Initiatives, but the name has been changed to ICLEI – Local Governments for Sustainability. http://www.iclei.org & http://www.icleiusa.org

percent as a realistic achievable goal. Further reductions can be made and will certainly be attempted, within budget and physical constraints. Measuring emissions has helped many organizations understand the connection of efficiency to reducing emissions. Identifying sources of emissions to create a GHG profile and management strategies may help local governments to prepare for and respond to the potential impact of new regulations. Voluntarily reporting GHG emissions provides local governments with a pathway to distinguish, make public, and promote their environmental stewardship. Preparing a GHG emissions inventory can help inform management, constituents, employees, and the public about a local government's GHG emissions profile.

The next step in the International Council for Local Environmental Initiatives (ICLEI) process is to produce a Local Action Plan for the City of Richmond Heights, to provide recommendations for reducing greenhouse gases, which could potentially save operational funding for the city as well. Frequently organizations have devised process improvements, implemented technological improvements, to ultimately save money and resources while reducing GHG emissions. Saving money on operations will free up money for additional actions and could fund a substantial part of GHG reduction measures. Grants may also be available to assist with opportunities. Some measures involve training and cost nothing to implement. Awareness and education play a large part in the successful implementation of any major strategy of GHG emissions.

This report was completed with the help of (ICLEI) Local Governments for Sustainability using their Clean Air and Climate Protection Software (CACP). The inventory data consists of two major sections: the municipal government emissions and the community emissions. It is not possible to measure actual emissions from all sources in a given year. This inventory reflects an approximation of emissions from energy usage data from the various sectors. This method was the most accurate within cost effective limits. It is the most commonly used method by cities across the world.

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Climate Change Background

Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming evidence suggests that human activities are increasing the concentration of greenhouse gases, most notably the burning of fossil fuels for transportation and electricity generation which introduces large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise.

Local Weather Changes

A recent report from the Department of Natural Resources states that the overall precipitation in St. Louis has already increased 10 to 20 percent since the 1950s. Precipitation is expected to continue to increase, especially in winter and spring, resulting in rising water levels and potential flooding for some areas. Weather and temperature changes will also bring more frequent and severe thunderstorms. Meanwhile, models predict a 36 percent increase in heat waves here, according to the report. That translates to an average of 1.9 heat waves per year instead of 1.4, lasting 14.2 days. Previously heat waves lasted an average of 10.3 days.

Flood risk has already increased over the past few decades along the Mississippi River near St. Louis due to increased flows, which tend to last a month or longer. Record rainfall in the Mississippi River watershed in April and May 2011, combined with springtime snowmelt, created deadly flooding throughout the Midwest. Because of heavy flow continuing to come down the river as of June 2011, the river is projected to be near flood stage all summer. Increased flooding puts floodplain development at risk of damage. After the deadly 1993 flood, levees were fortified lulling people into a false security as development continues despite the risk. Missouri floodplain laws have been criticized as some of the weakest in the nation. Formal review of flood control policy concludes that the best strategy for reducing flood losses is to limit or reduce infrastructure on floodplains. [3]

Wildlife such as the snowy owl and the American golden plover, seen occasionally in Missouri, are at risk. An Audubon Society survey has concluded that birds are moving north. Plant habitats are shifting north as well. The Arbor Day Foundation has determined that most of Missouri has moved into an entirely different plant hardiness zone in less than 20 years. [4]

In response to the problem of climate change, many communities in the United States are taking responsibility for addressing emissions at the local level. Since many of the major sources of greenhouse gas emissions are directly or indirectly controlled through local policies, local governments have a strong role to play in reducing greenhouse gas emissions within their boundaries. Through proactive measures around land use patterns, transportation demand management, energy efficiency, green building, waste diversion, and more, local governments can dramatically reduce emissions in their communities. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts. While this Plan is designed to reduce overall emissions levels, as the effects of climate change become more common and severe, local government adaptation policies will be fundamental in preserving the welfare of residents and businesses.

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ICLEI Process

ICLEI U.S.A. provides a framework and methodology for local governments to identify and reduce greenhouse gas emissions, organized along five milestones:

1. Conduct an inventory and forecast of local greenhouse gas emissions
2. Establish a greenhouse gas emissions reduction target
3. Develop a climate action plan for achieving the emissions reduction target
4. Implement the climate action plan
5. Monitor and report on progress.

This report represents the completion of ICLEI's Climate Mitigation Milestone One and provides a foundation for future work to reduce greenhouse gas emissions in Richmond Heights.

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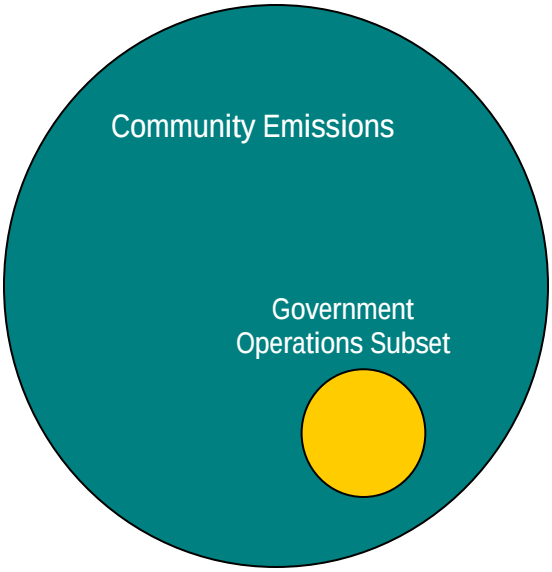
Climate Change Mitigation Activities in St. Louis Area

East-West Gateway Council of Governments was awarded a $4.6 Million HUD grant in 2011 as part of a growing recognition that citizens and urban leaders need to understand economic factors, climate change, and regional issues combine to impact quality of life in the metro area. The three year grant will enable planning and collaboration across jurisdictional boundaries as government works with local citizens. The goals of this grant are to create a plan which ultimately will stimulate the local economy while reducing GHG emissions and educating consumers about sustainability.

The City of Richmond Heights is working with the Friends of the City of Richmond Heights; a citizen led nonprofit organization, to implement sustainable solutions wherever feasible. The City will use an Energize Missouri grant to upgrade lighting in several buildings which will save energy and greenhouse gas emissions, and local tax dollars. An internal committee was formed to brainstorm, initiate, and implement sustainability efforts between the City of Richmond Heights staff and the public. The City of Richmond Heights will be undergoing an energy audit which will eventually lead to retrofit of all Richmond Heights city buildings, to improve energy efficiency and reduce Richmond Heights's energy consumption. The City has already adopted the 2006 International Residential Code (IRC), a complete, stand-alone residential code that establishes minimum regulations for one and two-family dwellings and townhouses using prescriptive provisions. It is founded on broad-based principles that make possible the use of new materials and new building designs, including sections on solar, gray water, energy efficiency, and hydronic piping. [5]



In addition, St. Louis and the City of Richmond Heights have been working to attract green collar jobs and provide green job training opportunities to local residents, incorporating solar installation training and residential/commercial retrofit and conservation-oriented equipment training as an integral part of its ongoing job training program. [6] Other sustainability efforts are underway in Richmond Heights. To learn more, visit the City of Richmond Heights web site [7].

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas emission reductions requires identifying baseline levels and sources of emissions in the community. As local governments have continued to join the climate protection movement, the need for a standardized approach to quantify GHG

emissions has proven essential. Standard processes of accounting for emissions have been developed to which our inventory adheres. The City of Richmond Heights used the International Local Government GHG Emissions Analysis Protocol (IEAP) to inventory the City's community emissions and the Local Government Operations Protocol (LGOP) to inventory GHG emissions from the City of Richmond Heights operations and activity. The government operations inventory is a subset of the community inventory. For example, data on commercial energy use by the community includes energy consumed by municipal buildings, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles. The government operations inventory is a subset of the community-scale inventory. By analyzing emissions in this manner, The City of Richmond Heights's local government is enabled to understand its own impact within the community and lead by example to reduce its impact on climate change.

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Quantifying Greenhouse Gases Emissions

Establishing a Base Year

A primary aspect of the emissions inventory process is the requirement to select a base year with which to compare current emissions. After considering the amount and types of data available for each of several recent years, this greenhouse gas emissions inventory uses 2008 as its base year, since most of the data was available for review. The forecast review is planned for 2013. Ideally a baseline year is typical in weather and not unusual, which would tend to skew analysis. Although local cities may want to compare themselves with each other, each city faces unique challenges and scenarios, which make comparison difficult. The intent of the inventory is to compare your city's efforts in the future with respect to meeting your goals.

Emission Types

The Local Government GHG Emissions Analysis Protocol (IEAP) and Local Government Operations Protocol (LGOP) recommend assessing emissions from the six internationally recognized greenhouse gases regulated under the Kyoto Protocol as listed in Table 1. Greenhouse gas emissions are commonly aggregated and reported in terms of equivalent carbon dioxide units,

or CO_2e. This standard is based on the Global Warming Potential (GWP) of each gas, which is a measure of the amount of warming a greenhouse gas may cause, measured against the amount of warming caused by carbon dioxide. Converting all emissions to equivalent carbon dioxide units allows for the consideration of different greenhouse gases in comparable terms. For example, methane is twenty-one times more powerful than carbon dioxide on a per weight basis in its capacity to trap heat, so the CACP software converts one metric ton of methane emissions to 21 metric tons of carbon dioxide equivalents.

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Table 1: Greenhouse Gases

Greenhouse Gas	Chemical Formula	Global Warming Potential
Carbon Dioxide	**CO_2**	**1**
Methane	**CH_4**	**21**
Nitrous Oxide	**N_2O**	**310**
Hydrofluorocarbons	**Various**	**43-11,700**
Perfluorocarbons	**Various**	**6,500-9,000**
Sulfur Hexafluoride	**SF_6**	**23,900**

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Quantification Methods

Greenhouse gas emissions can be quantified in two ways and both methods were used to generate this inventory:

- Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.

- Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the following basic equation is used: Activity Data x Emission Factor = Emissions

Activity data is a reference to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used in composing this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g. lbs CO_2/kWh of electricity). Table 2 demonstrates an example of common emission calculations that use this formula.

Table 2: Basic Emissions Calculations

Activity Data	Emissions Factor	Emissions
Electricity Consumption (kWh)	**CO_2 emitted/kWh**	**CO_2 emitted**
Natural Gas Consumption (Therms)	**CO_2 emitted/Therm**	**CO_2 emitted**
Gasoline/Diesel Consumption (Gallons)	**CO_2 emitted /Gallon**	**CO_2 emitted**
Vehicle Miles Traveled	**CH_4, N_2O emitted/Mile**	**CH_4, N_2O emitted**

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CACP 2009 Software

To facilitate community efforts to reduce greenhouse gas emissions, ICLEI developed the Clean Air and Climate Protection 2009 (CACP 2009) software package in partnership with the National Association of Clean Air Agencies (NACAA) and the U.S. Environmental Protection Agency (EPA). CACP 2009 is designed for compatibility with the Local Government Operations Protocol (LGOP) and determines emissions by combining activity data (energy consumption, waste generation, etc.) with verified emission factors.

The CACP software has been and continues to be used by over 600 U.S. local governments to reduce their greenhouse gas emissions. However, it is worth noting that, although the software provides governments with a sophisticated and useful tool, calculating emissions from energy use with precision is difficult. The model depends upon numerous assumptions, and it is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by the model as an approximation of reality, rather than an exact value.

Evaluating Emissions

There are several important concepts involved in the analysis of emissions arising from many different sources and chemical/mechanical processes throughout the community. Those not touched on already are explored below.

Emissions by Scope

For both community and government operations, emissions sources are categorized relative to the geopolitical boundary of the community or the operational boundaries of the government. Emissions sources are categorized as direct or indirect emissions – Scope 1, Scope 2, or Scope 3. The prevention of double counting for major categories such as electricity use and waste disposal is one of the most important reasons for using the scopes framework for reporting greenhouse gas emissions at the local level. The Scopes framework identifies three emissions scopes for community emissions:

- **Scope 1:** All direct emissions from sources located within the geopolitical boundary of the local government.

- **Scope 2:** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the geopolitical boundary of the local government, but that rely upon emissions-producing processes located outside of government jurisdiction.

- **Scope 3:** All other indirect or embodied emissions not covered in Scope 2 that occur as a result of activity within the geopolitical boundary.

Scope 1 and Scope 2 sources are the most essential components of a community greenhouse gas analysis as these sources are typically the most significant in scale, and are most easily affected by local policy making.

Similar to the community framework, the government operations scopes are divided into three main categories:

- **Scope 1:** Direct emissions from sources within a local government's organizational boundaries that the local government owns or controls.

- **Scope 2:** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

- **Scope 3:** All other indirect emissions not covered in Scope 2, such as emissions from up-stream and downstream activities that occur as a result of activities within the operational boundaries of the local government, emissions resulting from the extraction of and production of purchased materials and fuels, contracted services, and waste disposal.

As with the community inventory, Scope 1 and Scope 2 sources are the most essential components of a local government greenhouse gas analysis because these sources are usually significant in scale and are directly under the control of local governments. Local governments typically have indirect control over Scope 3 emissions. For example, solid waste generated from government operations is included as Scope 3 because of the unique circumstances in which emissions are generated – emissions from waste are generated over time as the waste decomposes and not directly in the base year.

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Emissions by Sector

In addition to categorizing emissions by scope, this inventory examines emissions by sector. Many local governments find a sector-based analysis more relevant to policy making and project management, as it assists in formulating sector-specific reduction measures and climate action plan components. This inventory evaluates community and government emissions by the sectors listed in Table 3.

Table 3: Community and Local Government Sectors

Community	Government
Residential	**Buildings**
Commercial	**Streetlights**
Industrial	**Vehicle Fleet**
Transportation	**Employee Commute**
Waste	**Refrigerants**

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2008 Community Emissions Inventory

The community GHG emission inventory report has six sectors:

1. Commercial
2. Residential
3. Industrial
4. Transportation
5. Waste
6. Other Emissions

The sources of emissions of community-wide activity include residential electricity and natural gas usage, commercial electricity and natural gas usage, industrial electricity and natural gas usage, vehicular traffic, and city-wide solid waste.

Natural gas usage data for Richmond Heights' residential and commercial sectors was provided by Laclede Gas, a natural gas distributing utility in eastern Missouri. Residential and commercial electricity data for the community baseline data was collected from the Ameren-Missouri Customer Service System Area Report. Ameren Missouri is the electricity service provider for the City of Richmond Heights. Ameren Missouri generates electricity from coal, nuclear power, combustion turbines, which use natural gas or oil, and hydroelectric plants. Most of electricity in this region is generated at coal fired plants, which is carbon intensive and dirty compared to other energy sources. [8]

Equivalent carbon dioxide is a measure used to compare emissions from various greenhouse gases using the global warming potential of carbon dioxide as the standard. Metric tons of equivalent carbon dioxide ($MtCO_2e$) are the standard unit of measurement used in Richmond Heights' baseline greenhouse gas inventory.

In 2008, the City of Richmond Heights emitted approximately 243,621 metric tons of CO_2e with transportation contributing the majority of emissions at 50.5 percent. The low contribution for waste can be attributed to the success of the mandatory recycling program in Richmond Heights.

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Community Summary

Table 4: Total Community GHG Emissions by Sector, 2008

Sector	GHG Emissions as (%CO_2e)	GHG Equivalent Emissions (Metric Tons CO_2e)	Energy (MMBtu)
Residential	18.4%	44,855	583,346
Commercial	30.7%	74,688	727,784
Industrial	0.1%	127	1,002
Transportation	50.5%	123,150	1,681,265
Waste	0.3%	801	N/A
Totals	**100.0%**	**243,621**	**2,993,397**

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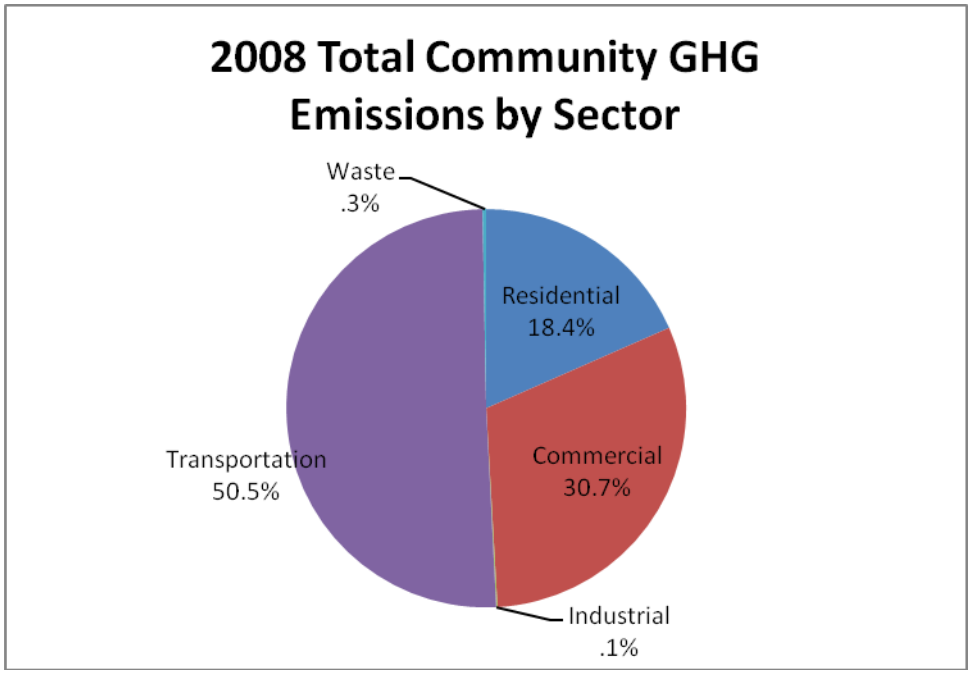
Figure 1: Total Community GHG Emissions by Sector, 2008



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The emissions and energy use from each major energy source are graphically displayed in Table 5. Richmond Heights used 176,401,505 kWh in 2008. Per capita 2008 electricity usage was 19,228 kWh. According to the U.S. Energy Administration; Missouri's overall energy consumption is about average among the U.S. Transportation and residential sectors lead in overall Missouri energy consumption. [9]

Table 5: Community GHG Emissions per Household, 2008

Number of Occupied Housing Units	***4,942**
Total Residential GHG Emissions (metric tons CO_2e)	**44,855**
Residential GHG Emissions/Household (metric tons CO_2e)	**9.1**

Greenhouse gas emissions were estimated for the commercial, residential, and industrial sectors using natural gas and electric data. (*2005-2009 U.S. Census data)

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Table 6: Total Community GHG Emissions by Energy Source, 2008

Energy Source	GHG Emissions as (%CO_2e)	GHG Emissions (metric tons CO_2e)	Energy Equivalent (MMBtu)
Electricity	33.6%	81,924	602,053
Gasoline	43.2%	105,267	1,439,643
Natural Gas	15.5%	37,745	710,079
Diesel	7.3%	17,883	241,622
Paper Products	0.3%	631	-
Food Waste	0.1%	134	-
Wood/Textiles	0.0%	27	-
Plant Debris	0.0%	10	-
Totals	**100.0%**	**243,621**	**2,993,397**

Table 7: Total Community Energy Use by Sector, 2008

Sector	Electricity (kWh)	Natural Gas (Therms)
Residential	48,928,027	4,163,562
Commercial	126,217,101	2,936,058
Industrial	259,361	1,165
Streetlights & Traffic Lights	997,016	-
Totals	**176,401,505**	**7,100,785**

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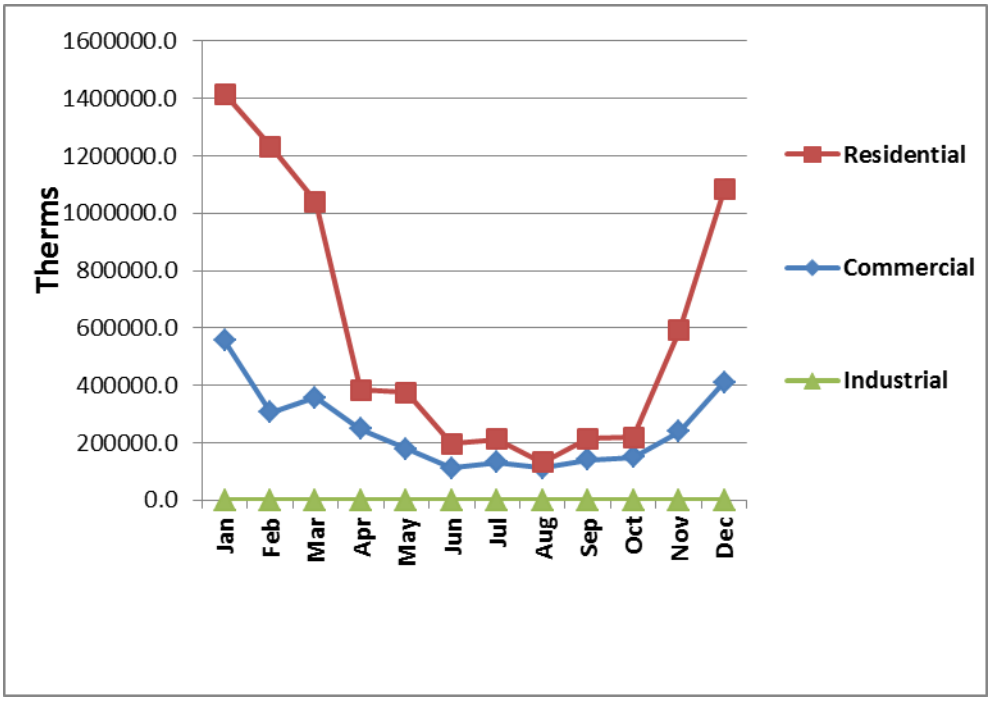
Community Natural Gas Usage

Community natural gas usage is displayed in Figure 3. Usage follows the expected trend of higher consumption during winter months. Community monthly electricity usage was not available for analysis.

Figure 2: Community Monthly Natural Gas Usage, 2008



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Transportation

Transportation is estimated for vehicles using roads using the boundaries of Richmond Heights, regardless of the trip origination point or whether traffic was just passing through the city. East-West Gateway Council of Governments provided data using a travel demand model, TransEval with model years of 2007, 2010, and 2014. The TransEval model distributes trips generated by different land uses to the highway networks and transit systems; by passenger car, light and

heavy duty truck traffic. 2007 data was used in the modeling analysis because of lower employment and population numbers. Daily vehicle miles are converted to annual vehicle miles for the CACP software to estimate total vehicle miles traveled and the associated GHG emissions. Transportation emitted approximately 123,150 metric tons of CO_2e in 2008. Compared to the other sectors, transportation is disproportionately high in GHG emissions. Notably Metrolink rail and bus service is provided in Richmond Heights, but is underutilized.

Emissions associated with local government employees traveling on behalf of the local government which are not owned or maintained by the local government are considered Scope 3 emissions. This includes emissions associated with personal and rented vehicles, mass transit, and air travel. Metro rail electricity usage and emissions are outside of local government control, but are included in the commercial sector and excluded from this inventory. Air travel is currently not included in the inventory per the ICLEI standard protocol. Protocol methods are adopted as they become more accessible and accurate, to ensure as much measurement uniformity across governments as possible.

Waste

The waste sector is the second smallest contributor to total community emissions, 801 metric tons, at .3 percent. Richmond Heights produced 3,251 tons of waste, diverting 794 tons of recycled materials, and 892 tons of composted yard waste. Recycling and composting avoided 416 CO_2 equivalent metric tons of GHG.

Waste emissions occur primarily from the natural decomposition of organic materials in a landfill, as methane. Although methane is 21 times as strong as carbon dioxide, waste is a very small component in the emissions from Richmond Heights. [10] Methane can be captured at the landfill and used as fuel for electricity generation. Estimated current methane reduction from capture at the Roxana, IL landfill is 4,625 tons/year with a CO_2 equivalent of CH_4 of 97,131 tons/year. According to the EPA web site, this landfill has been capturing methane since 1998.

[11] Allied Waste does not inventory waste streams. Consequently breakdown percentages used the ICLEI breakdown which was modified slightly to accommodate yard waste composting.

Table 8: Waste Breakdown

Waste Type	Waste Share
Paper Products	40.0%
Food Waste	15.0%
Plant Debris	2.0%
Wood/Textiles	6.0%
All Other Waste	37.0%
Totals	**100.0%**

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Other Emissions

It was determined that fire suppression units used in the City of Richmond Heights were “ABC” units which do not negatively impact the environment. Other impacting units have not been required for firefighting in five years, according to a City fire representative.

Other types of emissions are not directly under the control of the municipal government and are not inventoried separately from the direct measures listed above. Data such as the electricity used for water pumping is included in commercial data and excluded from this inventory. Likewise, wastewater treatment occurs outside of Richmond Heights and is outside local government’s operational control.

2013 Community Forecast

Forecasting of future GHG emissions is dependent on the use of population and employment indicators. Staffing at the City of Richmond Heights remains stable. Capital projects include no major office space gains or losses in the near future. Population forecasting for Richmond Heights indicates future population losses of 7 percent from 2007 to 2014, although vehicle miles traveled may increase 12 percent over the same period. [12] Future inventory processes

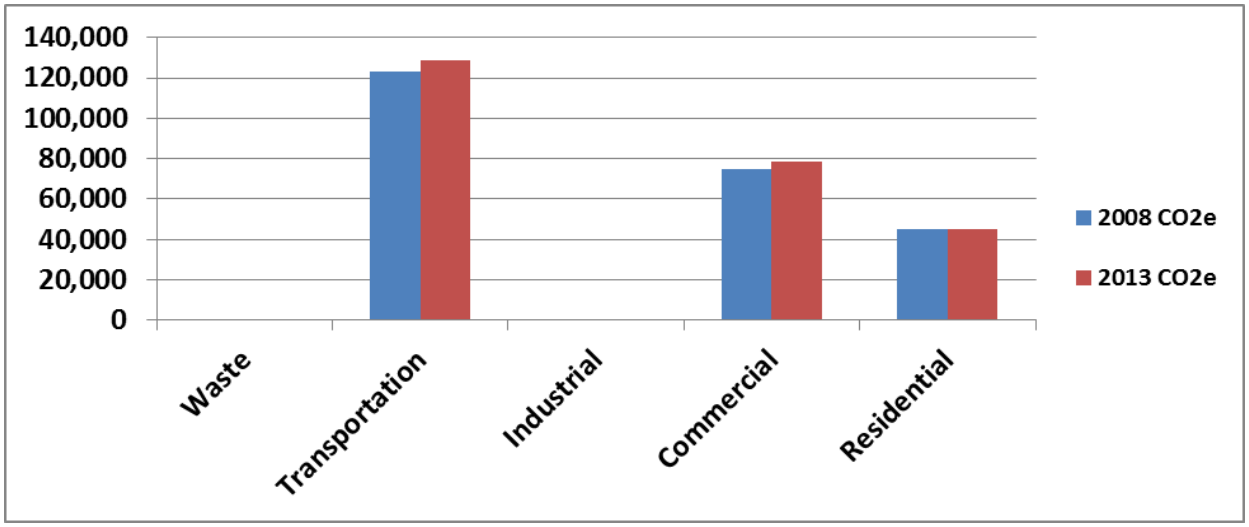
rely on similar uses of space for comparison to determine effectiveness of GHG reduction efforts.

Under the business as usual scenario, the City of Richmond Heights' community GHG emissions are expected to grow, despite a small drop in population. Without reduction efforts GHG emissions are estimated to rise 3.8 percent to 252,822 metric tons of CO_2e. Forecasted data in the CACP software was projected using no growth factor, due to the decline in population, despite the U.S. Census Bureau's projected overall growth estimate of 2.9 percent. [13]

Table 9: Community Emissions Forecast By Sector

Community Emissions Growth Impact By Sector (Metric Tons)	2008 CO_2e	2013 CO_2e	Percent Change
Waste	801	822	**2.6**
Transportation	123,150	128,520	**4.4**
Industrial	127	127	**0.0**
Commercial	74,688	78,498	**5.1**
Residential	44,855	44,855	**0.0**
Total	243,621	252,822	**3.8**

Figure 3: Community Emissions Forecast for 2013



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While overall emissions at Richmond Heights may rise slowly, the demand for fossil fuels (gasoline and coal) is expected to increase greatly with the predicted growth of the U.S. and global economies. The dominant factor affecting U.S. emissions trends is CO_2 emissions from fossil fuel combustion, which increased by 21.8 percent from 1990 to 2007. Greenhouse gas emissions are expected to continue to rise in the future for some time since developing countries such as China and India will be the primary source of new emissions. Emissions do not respect boundaries, so ultimately everyone's emissions matter. Although scientists can model climate change scenarios, the magnitude and speed of climate change is unknown. While adaptation will be required to some extent, current actions can mitigate some of the future emissions and should be part of local government planning. [14]

2008 Government Operations Inventory of Emissions

During the year of 2008, the City of Richmond Heights municipal operations generated approximately 3,229 metric tons of CO_2e. The city paid about $638,633 for electricity, natural gas, and fuel for the municipal buildings and fleet in 2008. The government side of the inventory consists of the following sectors:

1. Buildings
2. Vehicle Fleet (includes maintenance equipment)
3. Employee Commute
4. Refrigerant Emissions
5. Lighting

The buildings sector includes all buildings owned and operated by the city. Buildings include City Hall, Public Works, Parks and Recreation, The Heights, and Public Safety. Public Safety

houses fire and police staff. The Public Safety Dispatch Office is administered out of Richmond Heights, collaborating with Maplewood, Clayton, Shrewsbury, Webster Groves, and Olivette. The Heights facility includes a gymnasium, swimming pool, fitness center, and a library. City Hall contains the building department and municipal court facilities. Public Works and Parks and Recreation share a building. The KWH usage includes street lighting and pedestrian scale lighting, parks and playground lighting, buildings used for city warehousing, and miscellaneous property. Some of the miscellaneous property was converted to parking, was sold, or will be sold. Vehicle fuel usage is divided between the fleet, all maintenance and landscaping equipment, and a 500 Kilowatt generator. The generator provides backup power for Public Safety and the City Hall buildings. Employee commuting emissions are included in community emissions but are broken out for information and comparison here. Lighting includes only lights owned by the city. The only traffic signal owned by the city is on Dale Avenue, next to the Public Safety building, which is included in City Hall electricity usage. All other traffic signal lights are light emitting diode (LED) and are owned by St. Louis County. Ameren Missouri has various types of exterior street lighting and is overseeing a light inventory, which will be complete in the near future. [15] Government emissions, energy usage and cost are broken down by various methods in the following Tables and Charts.

Table 10: Total Government GHG Emissions by Sector, 2008

Sector	GHG Emissions (metric tons CO_2e)	Energy (MMBtu)	%CO_2e
Buildings	2,301	21,037	59.7
Vehicle Fleet	359	7,780	19.9%
Non Fleet Fuel	39	559	1.9%
Employee Commute	628	8,861	30.8%
Ext Lighting	492	3,616	22.6%
Misc Bldgs	1	7	2.5%
Refrigerant	37	N/A	1.3%
Total	**3,857.00**	**41,860.00**	**100.00%**

Note: Local government total of 3,229 metric tons plus 628 metric tons for employee commute = 3,857 metric tons.

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Figure 4: Total Government GHG Emissions by Sector, 2008

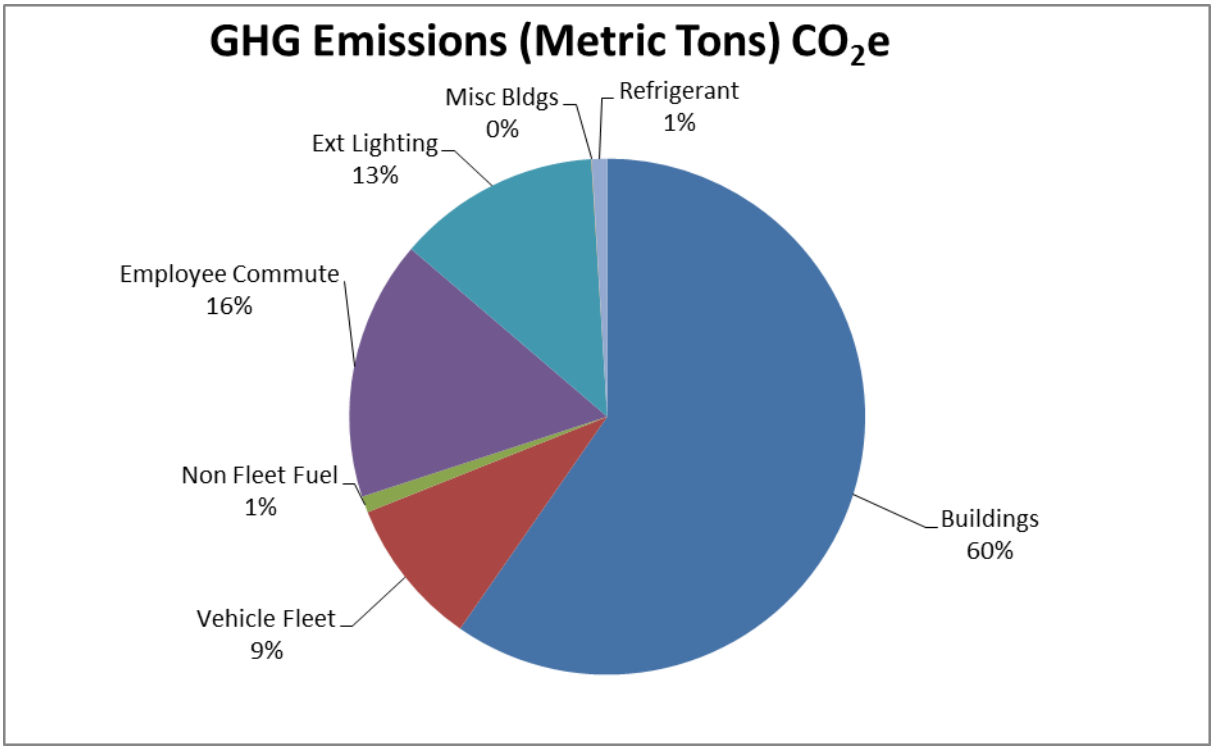

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Table 11: Total Government Energy Data Comparison, 2008

Department	kWh	% of Total kWh	Therms	% of Total Therms	Therms $	% of Total Therms $
Public Safety	817,507	16%	20,300.70	30.00%	$22,976.49	30.10%
Public Works	71,319	1%	3,830.30	5.70%	$4,678.84	6.10%
City Hall	428,693	8%				
The Heights	2,789,700	53%	32,405.40	47.90%	$34,674.87	45.40%
Parks/Recreation	59,972	1%	3,220.90	4.80%	$3,934.47	5.20%
Exterior Lighting	91,320	2%				
Street Lighting	968,080	18%				
City Warehouse	13,133	0%				
Misc. Property	2,071	0%	7,940.60	11.70%	$10,056.66	13.20%
Total	**5,241,795**	**100%**	**67,697.90**	**100.00%**	**$76,321.33**	**100.00%**

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While the City of Richmond Heights keeps actual fuel data usage and cost at the department level, the usage at the car/equipment unit level has not been tracked, partly due to hardware and software issues of aging equipment. Vehicle assets traditionally have been tied to license plate numbers. As vehicles are retired or sold, tracking becomes a challenge. Small grounds keeping equipment typically does not have a unique asset tag or hour meter to track usage for actual fuel tracking. Estimates of mileage and equipment usage were provided, but tracking fuel usage would help the City of Richmond Heights to understand and manage costs as fuel prices continue an upward trend. Seasonal weather patterns also dramatically affect usage patterns. Variability of fuel prices can dramatically impact the city's budget.

Figure 5: Government Total Therm Usage, 2008

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10,523	11,114	3,586	10,594	3,646	1,469	1,846	1,304	1,556	1,580	4,624	7,916

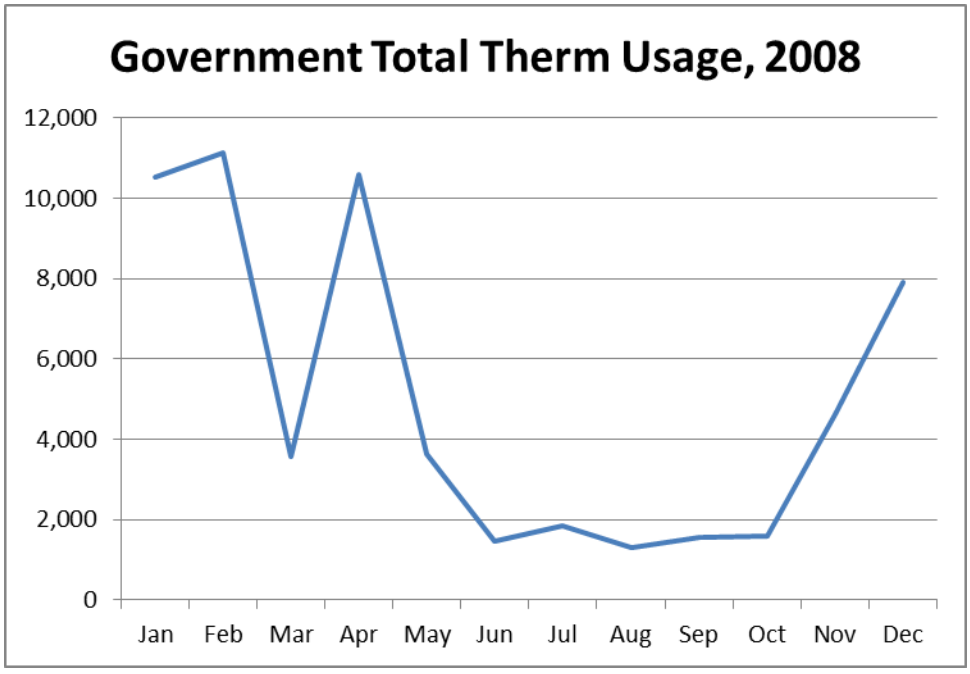
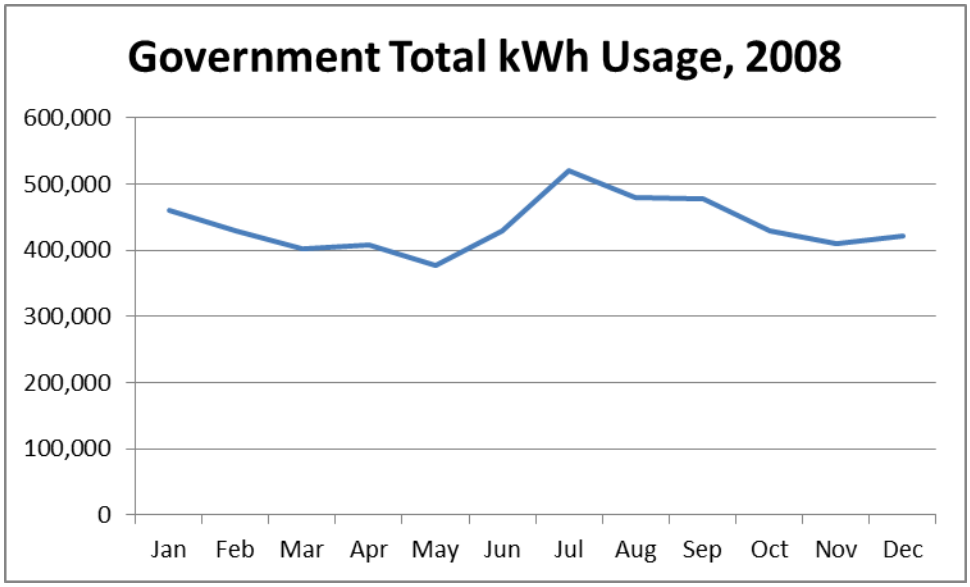


Figure 6: Government Total kWh Usage, 2008

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
459,233	429,542	401,828	408,495	376,548	428,948	520,779	479,415	476,525	428,736	409,842	421,904



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*Public Safety, Public Works, and The Heights use natural gas for heating and water heating. Other buildings use only electricity.

Table 12: Government Therm Usage by Month, 2008

THERMS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The Heights	5,532	5,891	*Unavailable	8,612	2,482	829	502	345	645	760	2,787	4,022
Public Works	1,575	1,711	1,074	521	153	15	11	9	11	72	475	1,424
Public Safety	3,416	3,513	2,512	1,461	1,012	624	1,333	950	900	748	1,363	2,470

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Figure 7: Government Therm Usage by Month, 2008

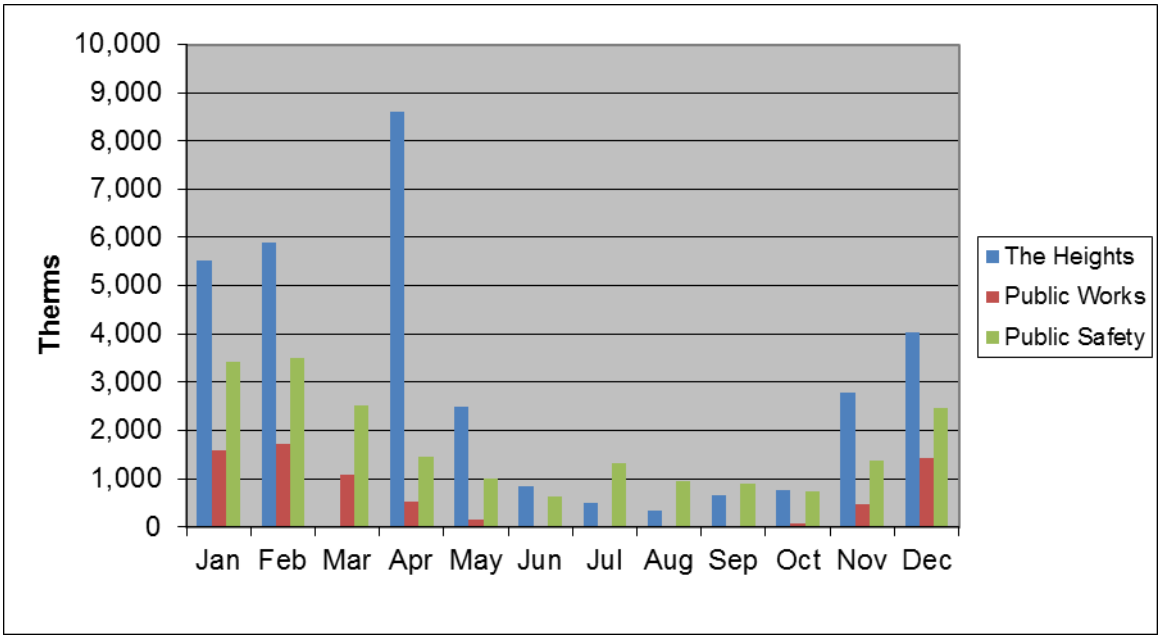

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Table 13: Government Therm Expense by Month, 2008

Therm $	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The Heights	$5,633	$5,984	*Unavailable	$8,875	$2,607	$910	$682	$480	$862	$1,007	$3,572	$4,063
Public Works	$1,773	$1,906	$1,285	$745	$196	$51	$50	$47	$50	$128	$791	$1,592
Public Safety	$3,569	$3,664	$2,687	$1,662	$1,092	$697	$1,729	$1,246	$1,184	$992	$1,868	$2,587

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Figure 8: Government Therm Expense by Month, 2008

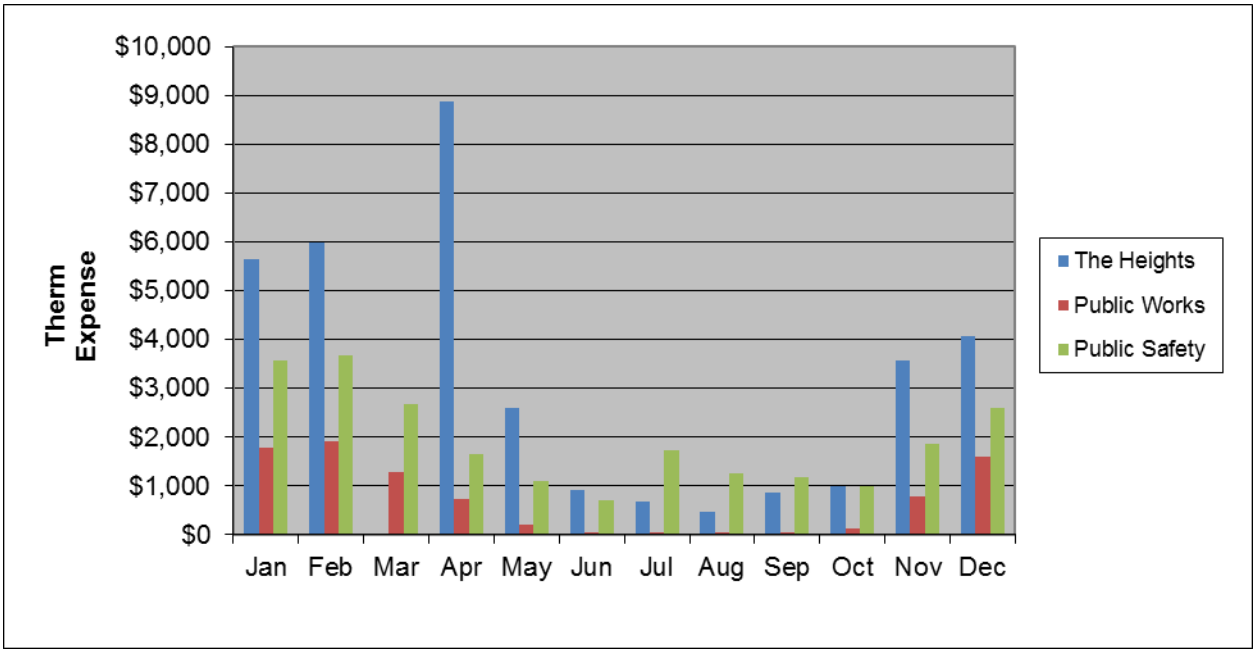

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Table 14: Government kWh Usage by Month, 2008

kWh	City Hall	Parks/Rec	Public Safety	Public Works	The Heights	Street Lights	CW	Other Ext.	Misc	Total
Jan	33,767	7,553	64,393	8,974	234,600	101,185	1,666	7,022	73	459,233
Feb	31,992	7,636	61,008	9,074	212,700	98,520	1,401	7,147	64	429,542
Mar	30,176	6,597	57,544	7,838	207,600	84,097	1,157	6,762	57	401,828
Apr	29,061	5,334	55,419	6,338	222,300	83,856	995	5,116	76	408,495
May	29,763	3,087	56,757	3,669	204,000	72,817	900	5,450	105	376,548
Jun	37,978	3,250	72,422	3,861	238,200	67,629	890	4,468	250	428,948
Jul	47,637	4,611	90,843	5,479	304,800	61,848	1,044	4,218	299	520,779
Aug	45,036	4,413	85,884	5,243	263,700	65,811	900	8,187	241	479,415
Sep	44,748	4,179	85,332	4,965	253,800	71,972	913	10,357	259	476,525
Oct	36,079	3,061	68,801	3,637	225,900	77,793	892	12,346	227	428,736
Nov	30,258	3,895	57,702	4,629	211,800	88,847	982	11,506	223	409,842
Dec	32,198	6,383	61,402	7,585	210,300	93,705	1,393	8,741	197	421,904
Total	**428,693**	**60,000**	**817,507**	**71,291**	**2,789,700**	**968,080**	**13,133**	**91,320**	**2,071**	**5,241,795**

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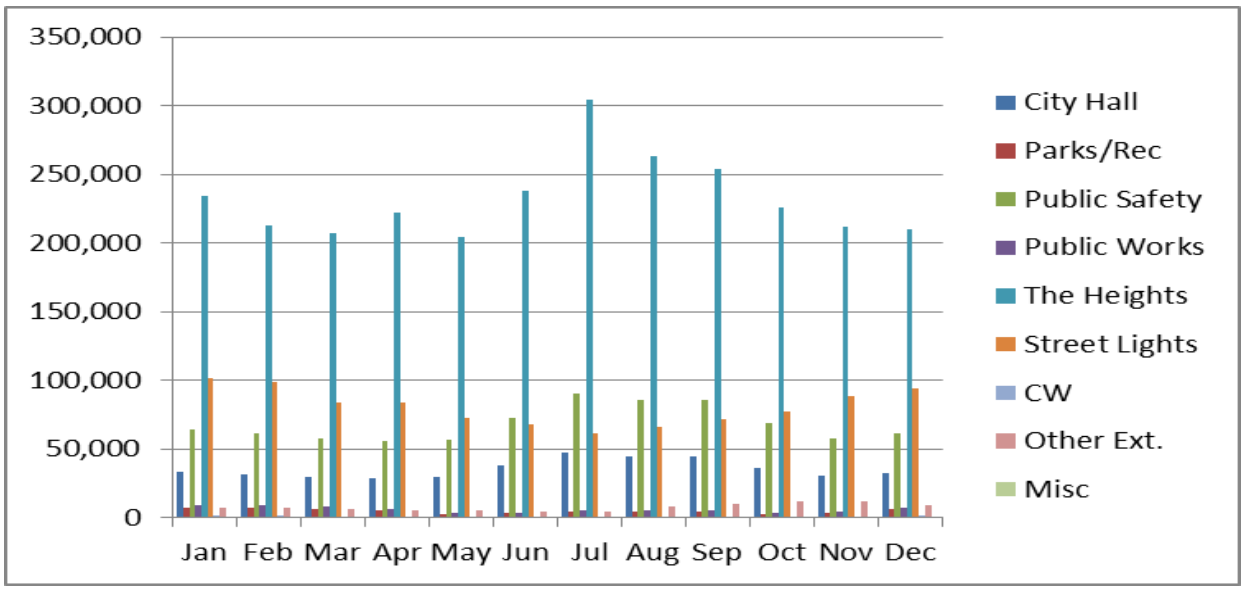
Figure 9: Government kWh Usage by Month, 2008



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*Data is prorated for Public Works and Parks & Recreation from single account data. Data is prorated for Public Safety and City Hall from single account data.

Fleet

Fleet consists of cars and trucks used for city employee transportation, off-road maintenance and park equipment, and the backup generator. Actual gasoline and diesel data was available at the departmental level, but fuel economy and mileage was estimated. The city has not tracked fuel at the unit level which would allow more accurate GHG emission reporting, especially since neither ICLEI nor the Department of Energy [16] has published MPG equivalents for off-road equipment. The ICLEI protocol also only breaks off-road equipment into two categories per fuel, despite having three groupings for diesel and six groupings for gasoline.

Despite a no-idling policy, the city's older vehicle models are less efficient, create more emissions, and cost the city additional expense for fuel. The closure of I-64/US40 in 2008

reduced need for Parks/Recreation staff by about 1 head and 1 vehicle, which was factored into the inventory. 2008 Parks/Recreation and Public Works data was incomplete, so current inventory was used to complete the inventory list.

Emissions from lawn mowers, snow blowers, chain saws, leaf vacuums, and similar outdoor power equipment are a significant source of pollution. Today's small engines emit high levels of carbon monoxide, hydrocarbons, and nitrogen oxides. These pollutants contribute to the formation of ozone. Off-road diesel engines contribute substantially to air pollution. In recent years, EPA has set emission standards for the engines used in most construction, agricultural, and industrial equipment.

The EPA is working to establish stricter emission standards: *The National Emission Standards for Hazardous Air Pollutants for Major Sources: Electric Generating Units for development of vehicle standards for cars and light-duty trucks with separate standards for medium- and heavy-duty trucks*. The EPA expects to finalize these standards in April 2012. [17]

Table 15: Government Departmental Fuel Expense by Month, 2008

Fuel $*	Bldg	Fire	Parks	Police	Public Works
Jan	$306.90	$916.70	$1,473.38	$6,237.60	$3,965.90
Feb	$150.20	$1,348.81	$733.56	$2,942.98	$3,289.20
Mar	$325.14	$2,519.38	$1,932.05	$5,709.33	$3,908.61
Apr	$548.64	$2,072.30	$1,796.69	$6,944.81	$3,705.28
May	$384.16	$2,707.28	$104.00	$0.00	$4,318.11
Jun	$400.96	$2,314.07	$2,969.40	$12,041.10	$2,889.84
Jul	$563.04	$3,178.26	$2,173.67	$8,403.98	$4,966.96
Aug	$378.49	$627.09	$2,338.40	$7,362.58	$4,029.39
Sep	$550.37	$2,484.58	$2,316.89	$7,702.74	$3,357.60
Oct	$205.02	$1,500.57	$952.12	$4,420.44	$2,928.25
Nov	$262.20	$218.16	$1,180.78	$4,039.55	$2,412.14
Dec	$138.85	$1,520.59	$1,024.66	$3,656.44	$2,169.70
Total	$4,213.97	$21,407.79	$18,995.60	$69,461.55	$41,940.98

Table 16: Government Departmental Fuel Usage by Month, 2008

Fuel (Gal) *	Bldg	Fire	Parks	Police	Public Works
Jan	102	305	489	2,079	1,310
Feb	50	414	235	978	1,040
Mar	101	687	570	1,768	1,129
Apr	152	532	488	1,929	1,009
May	98	641	27	0	1,056
Jun	97	532	724	3,005	692
Jul	138	750	527	2,060	1,204
Aug	101	168	668	1,969	1,052
Sep	146	659	613	2,038	888
Oct	68	451	311	1,474	927
Nov	130	108	547	2,000	1,070
Dec	80	732	572	2,101	1,126
Total	1,263	5,978	5,771	21,400	12,504

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*Fuel includes gasoline and diesel

Figure 10: Government Departmental Fuel Expense by Month, 2008

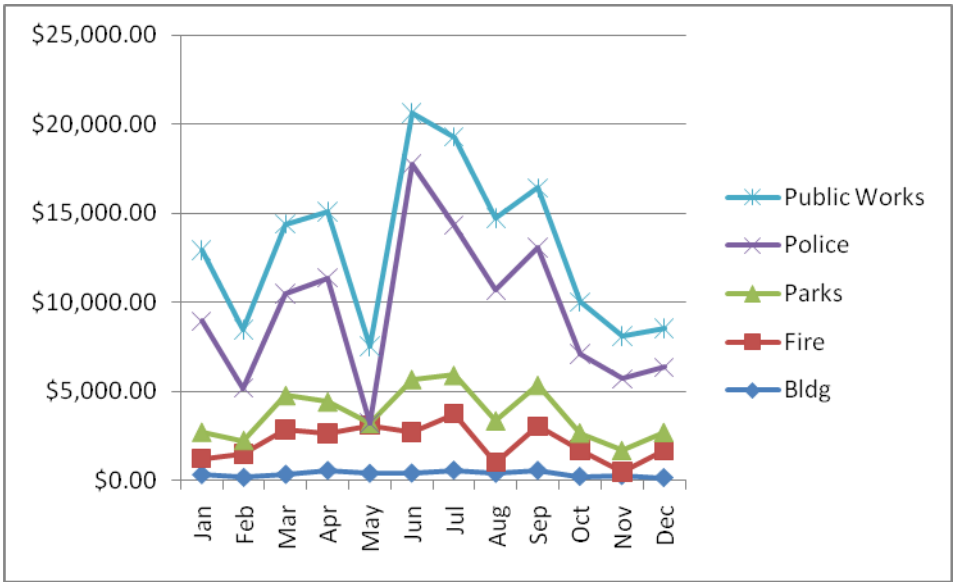
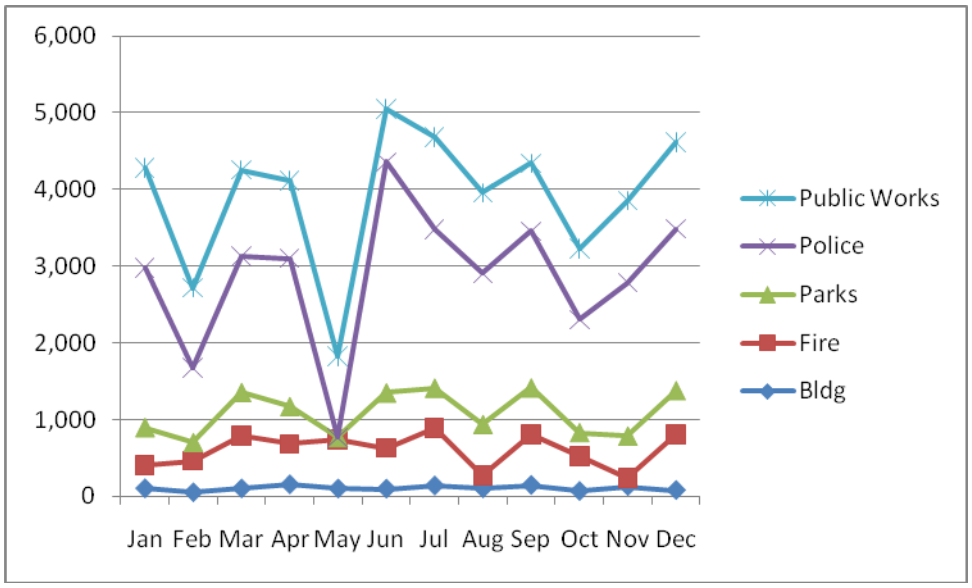


Figure 11: Government Departmental Fuel Usage by Month, 2008



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Employee Commute

Employee commuting contributed 626 CO_2e metric tons of GHG for about 31 percent of governmental emissions. A survey was sent to current employees to determine commuting habits in preparation for the inventory. All employees during 2008 were counted including part time and seasonal staff. The survey response rate was 55 percent. Gas prices averaged $3.27 a gallon while diesel averaged $3.51 in 2008. [18] Most people had multiple reasons for driving a personal car to work. A substantial number of employees had lengthy daily commutes.

Figure 12: Flexible Hours Allowing Commute

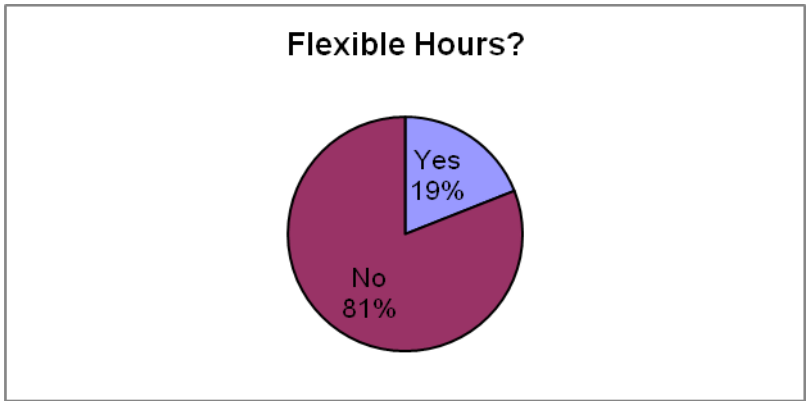

Figure 13: Reasons for Current Commute Mode

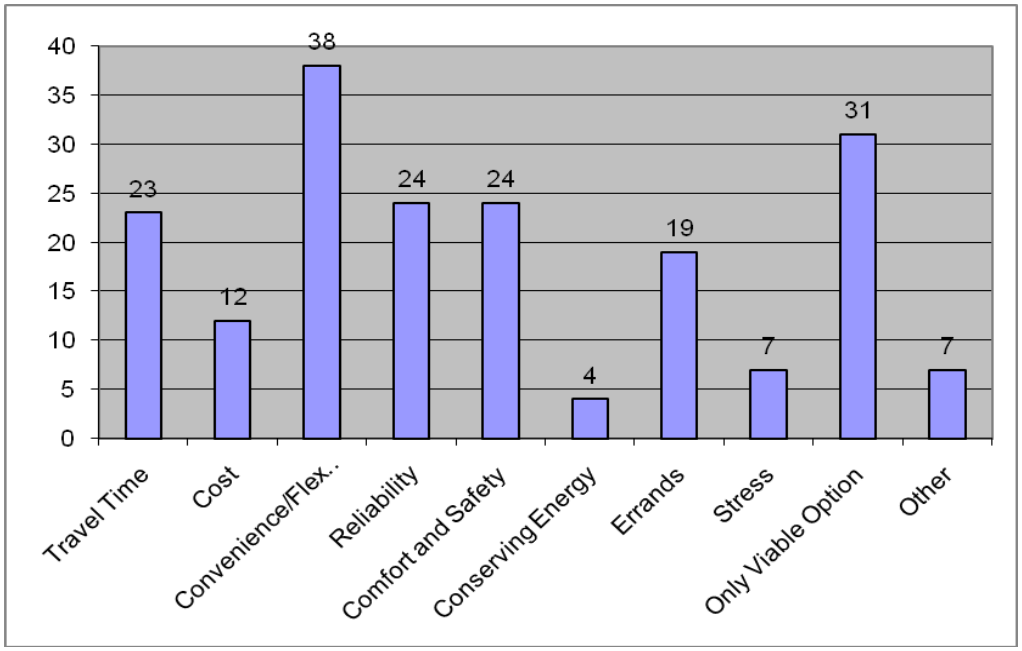

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Figure 14: Reasons Not to Carpool

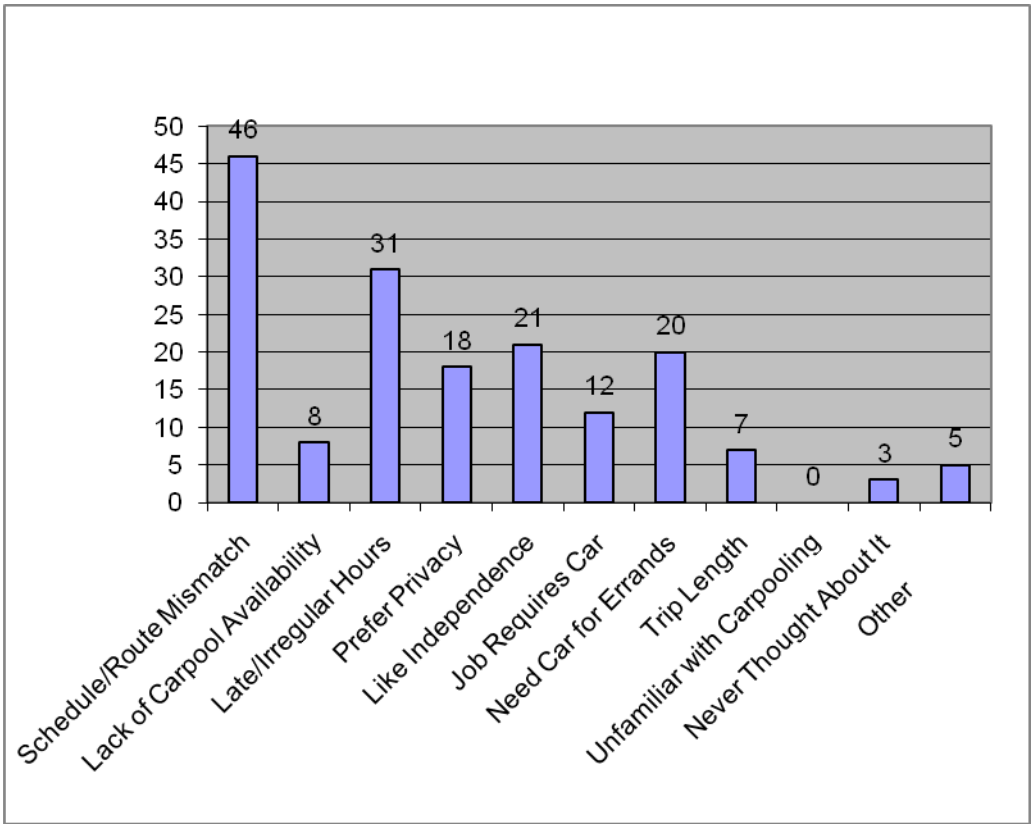

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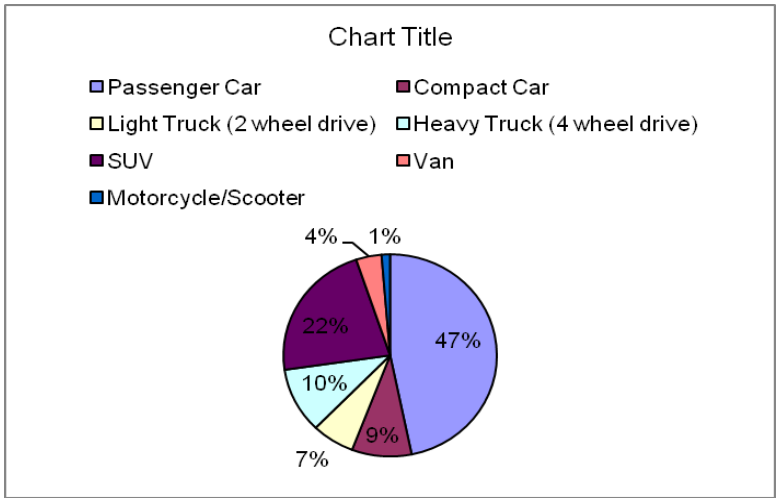
Figure 15: Commuting Modes, 2008



Lighting

Although exterior lighting was not a significant source of GHG emissions, the City of Richmond Heights spent a significant amount of money for exterior lighting in 2008, yet has no control over the kinds of street lights in use. These are owned by Ameren Missouri. Non building lighting data was reclassified into street lighting, exterior lighting, or miscellaneous lighting. See Table 14 and Figure 9 for lighting data.

Refrigerants/Fire Suppression

Refrigerants and certain fire suppression units are inventoried and included in the GHG inventory. EPA regulations are phasing out the use and import of ozone-depleting substances (ODS) such as HCFC-22 (better known as R22) under the Montreal Protocol. Many refrigerants have a very high global warming potential. Several local government air conditioning units contain R22. ICLEI protocol excludes R22 from the inventory process since it is already in phase out. While refrigerant may leak from units, especially mobile air conditioning units, many small establishments have equipment which is not sensitive enough to read small changes in refrigerant levels or their staff is unaware of the need to record losses. Consequently most of the city refrigerants were added to an inventory list, but estimation was used for most of the refrigerant

losses in this inventory. The refrigerant loss is a small part of the inventoried GHG emissions. It is not possible to inventory community refrigerant losses. The City of Richmond Heights should ensure vendors properly report and track refrigerant loss when selecting vendors in the future.

Fire suppression equipment used by the city, which is a potential GHG source, is a gaseous carbon dioxide fire suppressant (CO_2). One unit is carried on the fire truck for computer fires. However, these units are tested and loaded so that gases are almost completely recovered. Reportedly, the CO_2 canister has not been discharged in five years. Other suppression units are not GHG emitters.

Conclusion

By signing the U.S. Mayors' Climate Protection Agreement, the City of Richmond Heights made a formal pledge to reduce its greenhouse gas emissions. This report marks the completion of the first step in the reduction process: the establishment of a baseline and forecast GHG emission level, against which future inventories can be compared.

In the base year 2008, the City of Richmond Heights community emitted 243,621 metric tons of CO_2e as a whole. The majority of emissions came from the Transportation sectors with an emission of 123,150 metric tons of CO_2e. The City of Richmond Heights government was responsible for 3,229 metric tons of CO_2e. Unless abatement steps are undertaken, community GHG emissions are estimated to increase to 252,822 metric tons in 2013, despite a small drop in population.

Government bodies set the course with regulations and incentives, but the private sector controls a community's wealth, sets the economic direction, and provides goods and services crucial to everyday life. Individuals can and do make a difference in reducing community emissions. While this inventory had imaginary boundaries, greenhouse emissions don't stay in any single community. It's up to each of us to learn how to make a difference in our own community

because little changes really can add up if enough people contribute. [19]

In its effort to reduce emissions, the City of Richmond Heights may choose to follow the methods documented by ICLEI. Following the program outlined in their “Cities for Climate Protection Campaign”, the next step would involve adopting an emissions reduction target, documenting measures that have already been taken, and developing a Climate Action Plan to choose and implement additional measures.

When developing GHG reduction measures and developing a Climate Action Plan, the following factors should be considered: improved air quality, increased productivity, improved safety, strengthened community interaction, lower utility costs, better health, decreased oil consumption, improved health, lower public service costs, a stronger local economy, decreased greenhouse emissions, and others. In general, reduction strategies should focus on energy efficiency, renewable energy sources, decreased vehicle fuel consumption, alternative transportation methods, smart community design, waste reduction, increased green space and other sustainable strategies. Implementation of reduction techniques will provide tangible and intangible benefits to the City of Richmond Heights, creating a better, more livable community.

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Glossary [20]

Anaerobic - Without oxygen. Waste is decomposed by various strains of bacteria. Some of them operate only in the absence of oxygen. These are called anaerobic bacteria, and they are responsible for the methane that is produced when waste decomposes in a landfill.

Biogenic - Biogenic emission sources are emissions that come from natural sources, and need to be accounted for in photochemical grid models, as most types are widespread and ubiquitous contributors to background air chemistry. Often only the emissions from vegetation and soils are included, but other relevant sources include volcanic emissions, lightning, and sea salt.

CO2e - Carbon Dioxide Equivalent - When a greenhouse gas is released into the atmosphere, its warming effect is described by referring to the number of tons of carbon dioxide that would have to be released to create the equivalent warming effect. This is its CO_2e. Explanation: a number of gases have the effect of trapping heat when they are released into the Earth‘s atmosphere. The trapped heat causes the Earth to warm, causing global warming. Different gases are more or less potent at trapping heat, and this characteristic is called their warming potential. The warming effect of a given greenhouse gas depends both on its warming potential and on the amount of the gas released. Because a standard unit is needed by which the effect of different gases can be compared, and because carbon dioxide is the most common greenhouse gas, the effects of other gases are converted to how many metric tons of carbon dioxide would be required to have an equivalent warming effect. This is CO_2e.

Global-warming potential - (GWP) is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1). For example, the 20 year GWP of methane is 56, which means if the same weights of methane and carbon dioxide were introduced into the atmosphere, that methane will trap 56 times more heat than the carbon dioxide over the next 20 years.

Greenhouse Gas - Any of several gases (carbon dioxide, water vapor, methane, nitrous oxide, ozone, chlorofluorocarbons) that, when released into the atmosphere, have the effect of trapping heat. Different gases are more or less effective at trapping heat, and this characteristic is known as their warming potential.

Hydronics - is the use of water as the heat-transfer medium in heating and cooling systems. Some of the oldest and most common examples are steam and hot-water radiators. Historically, in large-scale commercial buildings such as high-rise and campus facilities, a hydronic system may include both a chilled and a heated water loop, to provide for both heating and aire

conditioning. Chillers and cooling towers are used separately or together as means to provide water cooling, while boilers heat water.

KWH - Kilowatt hour, equal to 1,000 watts. A KWH is commonly used by electric utilities to represent the amount of delivered energy and appears on most electricity bills in the U.S..

LED - A light-emitting diode is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability.

Lumen - For the purposes of this report this is a measure of visible light emitted from a light source.

Metric Ton or Tonne - A metric ton is equal to 1,000 kilograms. It is the most commonly used unit for expressing greenhouse gas emissions. Using a “metric ton“ over the U.S. customary “ton“ allows for the accurate comparison of emissions in other countries. It is also represented as “tonne“and is approximately 2,204 lbs.

MMBtu - BTU stands for British thermal unit. MMBtu is used to represent one million BTU. This unit of measure is used to describe energy content. Each type of fuel contains a different amount of energy. Therefore, the energy content of each individual fuel is made equal by relating it to the number of BTU per unit fuel.

Therm - A unit of heat energy most commonly used in reference to natural gas and is approximately equal to burning 100 cubic feet of natural gas. A therm is equal to 100,000 BTU.

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APPENDIX 1: Detailed 2008 Community Inventory Notes

New Ameren data was found after the initial report was released. The data was recalculated to determine a new total for the local government but the community total and forecast numbers did not change. Ameren cost data was not recalculated with the new release.

These notes are provided to document the procedures that were used to complete the inventory, so that future inventories can use similar procedures, thereby providing results that can be appropriately compared to the results of this inventory. ICLEI provides Excel based workbooks to process and store data; however these were received during the inventory after files had been created, so some data is stored in Excel workbooks with tabs for work as data is regrouped for final entry. All companion files are contained in a main folder.

Clean Air and Climate Protection (2009) software Version 3.0 (Tables Release Date: 20100901) requires some coefficient setup before entering data.

The eGRID emissions factors must be entered manually. This inventory used Table 1. eGRID Electricity Emissions Factors by eGRID Subregion SRMV (SERC Mississippi Valley) for the CO_2, N_2O, and CH_4 (all in lb/MWh).

This inventory used Table 3. NERC Electricity Emissions Factors for Criteria Air Pollutants for Inventory Years 1990 – 2005. Map Number (04) NERC (Mid-America Interconnected Network) for the NOx, SOx, CO, VOC, PM10 (all in lb/MWh).

2008 was chosen as the baseline year, since data is available and no extreme occurrences were noted which would skew the calculations. Since 2008 was determined to be the baseline year, we used the 2005 data found on the ICLEI web site in appendix A. It is already in the lbs/MWh format, which should be used. After selecting EPA eGRID (enter from LGOP) under region, I entered the 2008 through 2021 rows. **The baseline and forecast years should contain the same factors. IMPORTANT: This should be entered into the software, BEFORE the data is loaded.** There is no PM2.5 data to enter. Leave this value at 0. All the coefficients should be in the same format; ie lbs/MWh. In other words, you can't mix lbs/MWh with lbs/GWh.!

Residential, Commercial, Industrial

Total 2008 electricity use data for Richmond Heights was found in the City of Richmond Heights archived records, entered manually. Gilda Baldwin, Business & Community Affairs Coordinator at Ameren Missouri, provided totals for residential, commercial, and industrial for 2008, 2009, and 2010. The data was divided into Electric Usage and Dusk to Dawn Lighting. Further division into: Residential, Commercial, Industrial, (RCI) and Street and Highway. Street and Highway refers to traffic lights, sign lights, etc. Dusk to Dawn was divided into Residential, Res Bll Tog, Commercial, Com Bll Tog, Industrial, Ind Bll Tog, and Street and Highway. Dusk

to Dawn refers to streetlights that are pole mounted and controlled by sensors that turn lights on and off, but I could get no clear explanation for the Tog lines.

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Street and Highway cannot be accurately included in the government inventory because the data includes streetlights outside government control. There is no Streetlight sector in the CACP Software on the community side, which would be an appropriate place for Street and Highway data. Street and Highway was entered into the Commercial tab. Data was entered one record for each line of Ameren data.

Natural Gas usage was provided by Rob Arrol, Manager Corporate Communications at Laclede Gas. Data came broken down into each sector (Residential, Commercial and Industrial) for each month and was summed up for annual totals as well.

Transportation

Initially data was sought to use the same method that the City of Creve Coeur used, but it was discovered that East-West Gateway could simulate traffic for a given year, so a decision was made to use that data. Data from 2007 was used due to the population reduction. I provided Linda Yu with a boundary map of Richmond Heights to limit results to the city. Jurisdictional boundaries were based on the City of Richmond Heights Planning Department‘s Ward Maps found at

http://www.richmondheights.org/index.aspx?nid=429

Linda Yu (East-West Gateway, Council of Governments) provided the data model which produced daily vehicle miles traveled (VMT) miles for 2007, 2010, and 2014. The TransEval model is primarily concerned with vehicle quantities for traffic congestion, not emissions. Since the VMT was 458,000 VMT daily, multiply by 330 (per ICLEI protocol) for annual VMT. The model supplied listed VMT broken into passenger cars, light trucks, and other (Heavy Duty) trucks. Using a population chart (also from East-West Gateway COG, for vehicle type breakdown, I ended up with 7% heavy duty trucks, 39% passenger cars, and 54% light trucks/SUVs to distribute the miles. I used three records to spread the VMT. gasoline, Passenger Cars MY 1984 to 1993, gasoline, Light Trucks MY 1987 to 1993, diesel, Heavy Duty Vehicles All MYs. Forecasting was provided by John Posey, East-West Gateway COG, with a population loss from 10,303 (2007) to 9,534 (2014). I used these numbers to average out values for 2008, but decided to leave default settings (no growth) for forecasting, which still provided a rise in community GHG emissions in the “business as usual” scenario.

Metrolink is the only rail service inside the boundaries of Richmond Heights. No data was collected for Metrolink service. Metrobus emissions were provided at the bus level but not listed as an information item, since no other detailed data (such as the total number of buses and VMT for the buses) is known. Notably none of the buses are electric or hybrid at this time. There is a heliopad at a local hospital but emissions were not estimated for this or air traffic over Richmond Heights, per the ICLEI protocol.

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Waste

Annual waste tonnage was provided by Bola Akande from records kept and provided by Allied Waste. The CACP Software required the percentage of the total waste stream for five categories of waste: paper products, food waste, plant debris, wood/textile and all other. To determine the stream composition, the default CACP stream percentages had to be edited, based on the default protocol values with slight adjustment for the composting quantity. The annual waste tonnage data was divided into three categories: Trash, Recycle, and Yard Waste. The recycled material was left out of the inventory because the effects of recycling are accounted for by not contributing to total GHG emissions. Any increases in recycling from 2008 levels should be counted as a reduction measure. To determine what recycling and composting effects would have been if not in place, I plugged the total in with the revised numbers and determined the new total then removed this entry. Tony Lamantia (Municipal Account Representative, Allied Waste Services) provided final location of Richmond Heights waste (Roxana, Illinois). Methane capture information was deduced from the EPA (landfill documentation) web site.

Other

The wastewater data was collected as information, provided by Todd Heller, Division Manager at Metropolitan St. Louis Sewer District. The Lemay facility processes wastewater for Richmond Heights. The 2005 U.S. Census Bureau‘s annual population estimate of 9,174 was used to estimate Richmond Heights’ portion of emissions. This resulted in an emissions calculation of 386 metric tons of CO_2e an information item which did not get documented.

Part of the inventory process is determining which data to include and which data to exclude. For example, water (electricity for pumping) and associated emissions were not collected, deemed scope 3 per the protocol.

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APPENDIX 2: Detailed 2008 Government Inventory Notes

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Buildings

Data on electricity use came from Ameren Missouri monthly utility bills located in Richmond Heights City records. Data on natural gas use came from Laclede Gas reports.

Fuel prices for natural gas were estimated from data on the U.S. Energy Information Administration (EIA) web site <<http://www.eia.gov/>> - listed in dollars per thousand cubic feet and converted to natural gas measured in therms.

Conversion method for cost rates given in dollars per thousand cubic feet (Laclede gas in therms)

One therm is approximately 100 cubic feet 15.76 (dollars per thousand cubic feet)
15.76/1000 cu ft = X/100 cu ft

So 15.76 * 100 cu ft = 1000 X

1576/1000 = X or 1 therm would cost 1.576

Monthly electricity and natural gas usage were added together separately for each government building. City Hall and Public Safety bills were combined in 2008, so bills had to be apportioned. Note found in archived records stated that analysis from July 2005 to December 2007 determined that City Hall portion of the electric bill is 34.44%.

Public Works and Parks/Recreation share a building, so their bills all had to be apportioned as well. (Public Works 54.3%/P/R 45.7% Public Safety includes fire and police and was not separated. Public Safety Dispatch shares a facility with other cities. This fact was ignored for the inventory. The Heights includes a fitness center, indoor swimming pool, and a library.

Vehicle Fleet

Fuel usage data came from archived monthly gas usage reports and a report from the Finance department. Equipment lists and estimated mileage/hours came from each department. All actual gas and diesel purchases are tracked at the department level, but not at the vehicle/equipment level. Vehicles are tracked, but as cars are sold, data is not retained. A system has been proposed to allow better data capture for the next inventory using asset tags which are retired upon disposal, but saved for reference.

Vehicle classification was based on the descriptions provided in the CACP Software help files. An online estimation fuel usage guide was found for the generator but not for Parks/Recreation or Public Works. http://dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx

Vehicle mileage estimates and fuel economy were both used to estimate the fuel used by vehicles. The remainder was spread across the Parks/Recreation and Public Works equipment based on estimated hours of usage. Due to having actual fuel usage across departments, automobiles were grouped into logical similar fuel economy groupings with fuel quantities but had to be entered into CACP as VMT, which doesn't associate a total fuel cost. off-road fuel usage (Parks/Recreation and Public Works equipment, as well as the generator used gallons of fuel, which does have an associated fuel cost. Fuel estimates (average obtained from EIA web site) were used whenever actual fuel costs could not be applied for cost comparison.

Vehicles required 2 entries each to calculate CH_4 and N_2O and CO_2 accurately. CH_4/N_2O Only records use "default" Transport Average Set and "Highway VMT N_2O, CH_4 and CAP" Fuel CO_2 Set, whereas CO_2 Only records use "default" Fuel CO_2 Set and "Highway Fuel CO_2 Only" Transport Average Set. Limitations between data gathered and allowable entries required on the fly analysis and assumptions to be made at various points, especially sizing of vehicles and equipment.

Type	**Vehicle Type**	**N_2O**	**CH_4**	**NOx**	**SOx**	**CO**	**VOC**	**PM10**	**PM2.5**
Off-road Diesel	Agricultural Equip	0.26	1.44	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Diesel	Construction Equip	0.26	0.58	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Diesel	Large Utility Vehicle	0.26	0.58	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Agricultural Equip-All Yrs	0.22	1.26	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Construction Equip-All Yrs	0.22	0.5	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Large Utility Vehicle-All Yrs	0.22	0.5	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Recreational (Inc Motorcycles) - All Yrs	0.22	0.5	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Small UtilityVehicle-All Yrs	0.22	0.5	0.00	0.00	0.00	0.00	0.00	0.00
Off-road Gasoline	Snowmobiles-All Yrs	0.22	0.5	0.00	0.00	0.00	0.00	0.00	0.00

Type	Vehicle Type	N_2O	CH_4	NOx	SOx	CO	VOC	PM10
Gasoline	Heavy Duty Vehicles MY 1997	0.173	0.092	5.401	0.193	60.676	5.159	0.146
Gasoline	Light Trucks MY 1997	0.087	0.045	2.005	0.106	20.383	2.244	0.045
Gasoline	Passenger Cars MY 2005	0.008	0.015	1.475	0.079	15.820	1.622	0.034
Gasoline	Passenger Cars MY 1984 to 1993	0.065	0.070	1.969	0.084	22.877	2.413	
Gasoline	Light Trucks MY 1987 to 1993	0.103	0.081	2.473	0.110	27.274	3.212	0.060
Gasoline	Heavy Duty Vehicles MY 1985 to 1986	0.051	0.409	6.593	0.218	108.465	8.740	0.211
Diesel	Heavy Duty Vehicles ALL Mys	0.005	14.999	0.487	9.564	1.228	0.745	
Diesel	Light Trucks MY 1960 to 1982	0.002	0.001	1.884	0.502	1.371	0.685	,343
Diesel	Light Trucks MY 1983 to 2004	0.001	1.311	1.311	0.106	1.345	0.498	0.157

Local government kWh were recalculated in December, 2011. The recalculated government total of 3,229 metric tons of equivalent CO_2e compared to the community total of 243,621 metric tons of equivalent CO_2e is 1.33%.

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Employee Commute

A survey was sent using Survey Monkey to determine commuting preferences for full time current staff. Julie Echols provided the initial data report with names, hours, home zip codes, and departments. After estimating the total commute days for each person, estimating vehicle miles traveled for each person, based on hours worked and input from various areas on commuting habits, the total VMT for the Employee Commute sector was calculated. The home zip codes to Richmond Heights were used for the 2008 employees. Seasonal and part time staff was included in the VMT calculations, but not in the survey. Since the survey was anonymous and vehicle type for each person was unknown, the type of current automobile data was extrapolated back to 2008 to determine one universal auto, rather than trying to divide the total among SUVs, trucks, vans, etc. A single car with average fuel economy of 20.35 mpg was used to enter the total VMT, after compiling all the data. Total mileage was divided by the average to determine the total commuting fuel cost.

Streetlights and Traffic Signals

Data for the Streetlights and Traffic Signals sector came from Ameren Missouri utility bills and was included in the buildings and facilities sector, since it was not possible to break the data into a more detailed level. The types of lighting were broken down, based on the bill's description, account number, and from interviewing Planning and Public Works staff.

Entries for government Streetlights and Park/Playground and Pedestrian Scale lighting were only those that the City of Richmond Heights received an electric bill for. Data on other lighting, paid for by other sources, was provided in the community electricity data from Ameren Missouri and is accounted for in the community sector.

Refrigerants

Refrigerants were inventoried at all buildings. Some HVAC equipment has R22 refrigerant, which is being phased out, and is excluded from the inventory, per the ICLEI protocol. Archived invoices were reviewed for recharges of equipment and vehicles. Only a few units were recharged in 2008. Full charge quantities were established by finding information on the equipment face plates, calling vendors or manufacturers with model and serial numbers, or estimates when the other methods were unsuccessful. Where recharging was done in 2008, the actual quantities were counted. When no information is available, the ICLEI protocol advises the alternate method, which uses a loss percentage of the full charge, based on the type of unit. This method resulted in a relatively small quantity of any one leaked refrigerant; however, refrigerants have a "global warming potential" that varies by refrigerant type. Each type of refrigerant is entered into the software as a mobile or stationary unit.

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Fire suppression

The City of Richmond Heights has numerous “ABC” common fire extinguisher units at each building. The only units which have a potential to emit GHG are gaseous carbon dioxide units, per Gale Mathis at Weber Fire & Safety. Richmond Heights has one of these units on each large fire pumper truck. There is one backup truck. According to my fire representative, these units have not been discharged in five years. Weber Fire & Safety states that the recovery equipment for these units releases a miniscule amount of gas to the atmosphere, so no emissions were counted from fire suppression equipment.

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THERMS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTALS
The Heights	5,531	5,891	*Unavailable	8,612	2,482	829	502	345	645	760	2,787	4,022	**32,405**
Parks/Rec	720	781	491	238	70	7	5	4	5	33	217	650	**3,221**
Public Works	856	929	583	283	83	8	6	5	6	39	258	773	**3,830**
Public Safety	3,416	3,513	2,512	1,461	1,012	624	1,333	950	900	748	1,363	2,470	**20,301**
MISC Property	1,278	1,981	1,054	449	221	102	72	78	95	121	707	1,783	**7,941**
Therm Totals	**11,800**	**13,096**	**4,639**	**11,043**	**3,867**	**1,570**	**1,918**	**1,383**	**1,651**	**1,701**	**5,331**	**9,699**	**67,698**

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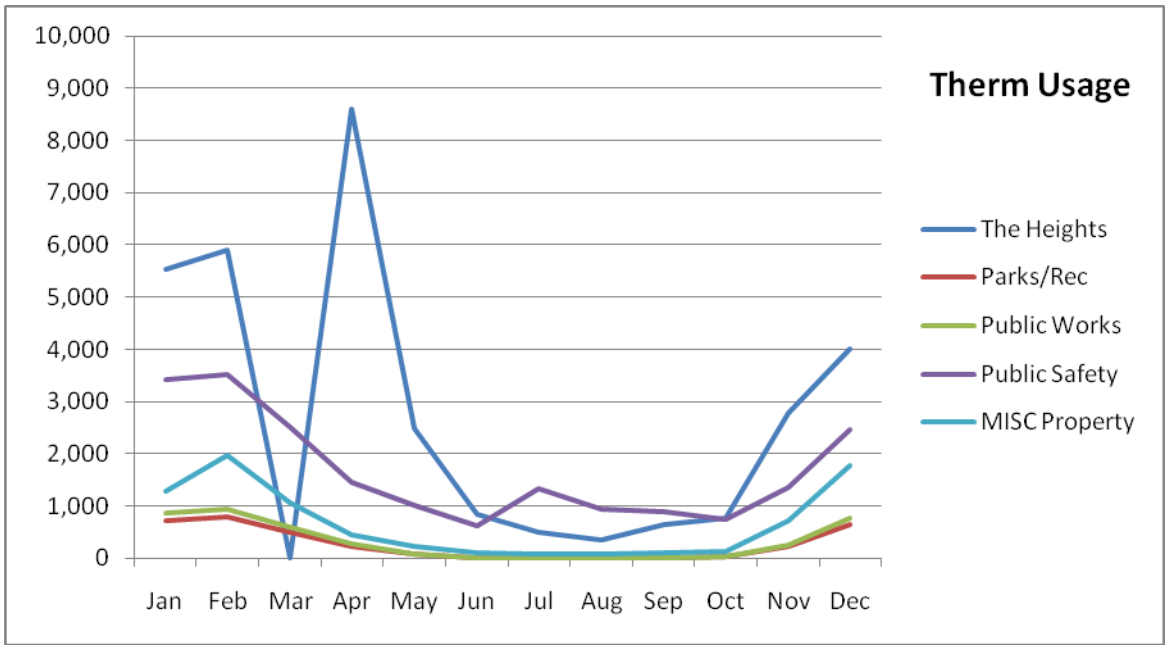

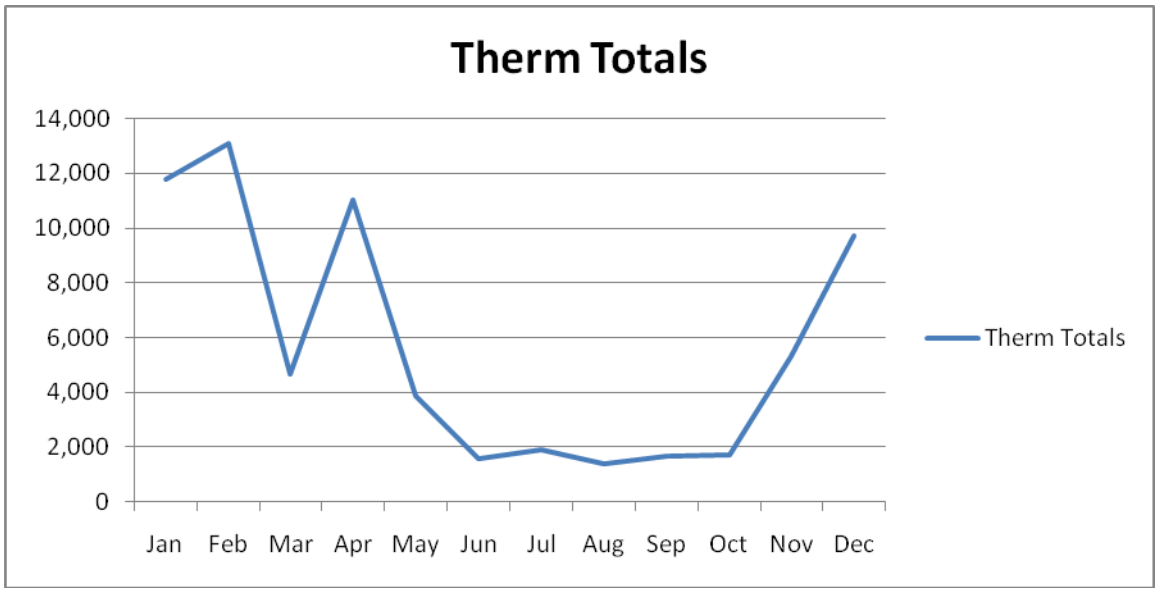

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